Mainstreaming water and transboundary cooperation into climate related documents

WATER CONVENTION

Contents

Background

The Programme of Work (PoW) 2019-2021 of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) includes contributing to global policy processes on water, climate change and disasters. The Task Force on Water and Climate, which is responsible for activities related to adaptation to climate change, including flood and drought management at its 10th meeting (1 May 2019) emphasized the importance of close cooperation between the water, climate and disaster risk reduction communities at national and international level and stressed the need to and benefits of further highlighting the importance of water and transboundary issues in global processes on climate and disasters, such as under the United Nations Framework Convention on Climate Change (UNFCCC). Given the central role of water in both mitigation and adaptation, it also encouraged countries to include water and transboundary cooperation in their updated nationally determined contributions as well as inter-sectoral, regional and basin-wide cooperation in their preparation. In addition, the Working Group on Integrated Water Resource Management at its 14th meeting (22-24 October 2019) stressed the importance of cooperation with global processes on climate, such as UNFCCC, and encouraged the participants to strengthen cooperation between the water and climate communities in their countries and basins.

Transboundary basins account for an estimated 60 per cent of global freshwater flow. Transboundary cooperation in mitigation and adaptation is thus crucial to prevent possible negative impacts of unilateral measures and to make addressing climate change more effective (for example, by reducing uncertainty through the exchange of data, enlarging the range and location of available measures, and sharing the costs and benefits). It also helps to prevent conflict, reduces existing knowledge gaps, and promotes peace and regional integration, as well as wider economic development (UN-Water, 2019). To support this, a session on how to mainstream transboundary aspects of water management into climate-related documents and river basin management planning was organised on 2 October 2020. This discussion was supported by a substantive background paper mainly focusing on how transboundary aspects of water management can be mainstreamed into NDCs. The focus of the paper is also determined by the fact that in 2020 countries are developing new or updated Nationally Determined Contributions in the framework of the Paris Agreement.

The scope of the present paper[1] is as follows: First, it describes why mainstreaming of water and transboundary cooperation is key to both adaptation and mitigation. Second, it describes how water and transboundary cooperation can be addressed in national policies and in the NDCs. Third, the paper proposes approaches and steps on how to mainstream transboundary aspects of water management into NDCs. Possible effects on water of mitigation and adaptation measures are presented respectively and finally some key messages and recommendations are elaborated. The paper serves as a background to provide options and approaches for countries to improve their NDCs and climate related strategies and plans.

Key messages

- Mainstreaming water as a cross-cutting issue into climate change planning is imperative.
- Applying an integrated approach to water management as management of a common good is recommended, which has to address the needs of water supply and sanitation as well as of other water-related sectors (e.g. energy, industry, agriculture, forestry, etc.) and ecosystems.
- Mitigation measures can have substantial effects on water management, often enlarging water use, and these effects should be accounted for in the NDCs.
- Adaptation measures can have climate change mitigating effects. Adaptation plans should therefore be included in the NDCs.

[1] The document has been developed and coordinated by Jos Timmerman (WaterFrames) as contribution of the Ministry of Infrastructure and Water Management of the Netherlands, in close cooperation with the Secretariat of the Water Convention.

- As the water connects the entire basin, water management should be done at the basin level. Transboundary effects and options for cooperation should therefore be included in the NDCs.

Executive summary

Water is a basic resource that is needed in virtually all processes in human society, ranging from food and energy production through industrial processes to drinking water and sanitation. Climate change makes water availability and water quality more variable and less predictable and increases the magnitude, development and frequency of extreme events (floods and droughts), affecting human society and socio-economic development. Unfortunately, many decisions made in industry, agriculture, utilities, etc. as well as in climate policies are taken without incorporating the water management possibilities and consequences. There is consequently an urgent need to account for the water management aspects of climate change in all climate related policies, strategies and plans.

Water management largely deals with providing all sectors with sufficient water of sufficient quality, meanwhile dealing with floods and droughts. Water management should therefore be considered as management of a common good and a basic resource, setting aside water supply and sanitation that can be considered as a sector. Water management needs to be done from a basin perspective, where upstream changes influence downstream and vice versa. When a basin is shared between two or more countries, there is a need for cooperation between those countries in water management to adapt to climate change more efficiently and to prevent possible negative impacts of unilateral measures. Such cooperation should be based on sharing benefits from a water management perspective and beyond, including climate change adaptation, sustainable development and conflict prevention. River basin organisations can play a connecting role in such cooperation.

Climate change mitigation measures can put pressure on water demand. For instance, the use of biofuels or applying Carbon Capture and Storage require substantial amounts of water that may not be available in water scarce situations. Similarly, climate change adaptation measures can influence water management, for instance when fencing off an urban area from flood leads to flooding of other areas. Development of mitigation and adaptation measures should therefore account for their effects on water management as well as for the effects of climate change on the water availability. Moreover, water management plays an important role in climate change mitigation, among others, by rehabilitation and maintenance of wetland, that can store more carbon than forests can. And water management is important in climate change adaptation, for instance, through mitigation of floods and droughts. To enable such incorporation of water management including the pertinence of transboundary cooperation at the basin scale into climate policies, this document provides a stepwise approach.

Introduction

Objectives

This background document is intended for climate decision makers, water managers and the expert community working on water and climate issues to:

1. provide information on the essential role of water management at the basin scale in climate change mitigation and adaptation; and
2. provide information on how countries can integrate transboundary and regional cooperation in water management into their climate planning (specifically their NDCs) and the benefits of doing so.

Why mainstreaming water?

Climate change influences society mainly through meteorological and hydrological changes (IPCC, 2014) making water availability and water quality more variable and less predictable and increasing the magnitude, development and frequency of extreme events (floods and droughts) (UN-Water, 2020). Also, sea level rise puts direct pressure on small islands, low-lying coastal areas, and deltas as well as indirect through saltwater intrusion in freshwater systems (Jiménez Cisneros et al., 2014).

Water is a basic resource that is needed in virtually all processes in human society, ranging from food and energy production through industrial processes to drinking water and sanitation. Also, water is needed to sustain ecosystems that are indispensable for a range of ecosystem services and for water resources management (UN-Water, 2018). Degraded ecosystems pose risks to drinking water and sanitation even with conventional treatment (Jiménez Cisneros et al., 2014). Meanwhile, climate change increases global water demand which will lead to increased competition for water resources (Timboe et al., 2019). For instance, as a result of increasing temperatures and demographic developments, there is a rising need for energy and food that in turn require additional water for their production.

Unfortunately, many decisions in industry, agriculture, utilities, etc. as well as in climate policies are taken without incorporating the water management consequences. There is consequently an urgent need to integrate water management concerns into decision-making while better trade-offs are made between the various water users, including across national boundaries within transboundary basins.

Box 1. Flash droughts

One phenomenon that gains more attention lately is the "short" or "flash" hydrological drought. Where generally drought is considered a slow developing disaster, flash droughts can create severely dry conditions in about 2–6 weeks. If these events occur during the peak of the growing season, they can kill off crops over large areas. Decreased rainfall, above-average temperatures, and low soil moisture all play a role in the development of flash droughts, often triggered by heat waves following a dry period. Climate change may aggravate the frequency and intension of flash droughts (Morton, 2020).

Water resources management should be an integral part of climate strategies and actions to be able to deal with climate change impacts and resulting trade-offs. And, because of its cross-cutting nature, water is central in attaining the targets set in the Paris Agreement. But while some 90% of the Intended Nationally Determined Contributions (INDCs) from 2015 that include an adaptation component explicitly refer to water resources, virtually none reference the need for resilient water management and policy approaches (GWP, 2018). Where the INDCs determine goals for their sectors (e.g., cities, energy, agriculture), water may become a limiting factor for these goals entailing the risk of conflicts between the sectors (Timboe et al., 2019).

In a transboundary basin, the competition for water may increase tensions between countries. For instance, a unilateral move by one country to adapt to climate change by building a dam could drastically reduce a river's flow downstream in another country (UN-Water, 2016). The prevailing response in transboundary freshwater resources management, fortunately, is still cooperation, though non-violent conflict is quite frequent (Bernauer & Böhmelt, 2020).

With all this in mind, there is a need for more mainstreaming of water into national climate policies as well as mainstreaming of climate in transboundary water cooperation. A risk-based approach to water management herein is justified; "*We can no longer assume that the water will be available when, where, and in the right quality we need, even in places that have not previously experienced water insecurity*" (Timboe et al., 2019).

Box 2. Water management and the water supply and sanitation sector

Water is often considered and treated as an economic sector, like energy and agriculture. Water, however, is an entity comparable to air or soil and needs to be managed as a common good.

The water supply and sanitation sector largely functions as utility management and is an important water user. It puts requirements on water management and influences the quantity and quality of the surface water and groundwater through discharges. The water supply and sanitation sector is comparable to other sectors in putting certain demands on surface water and groundwater and in having impact on them. It encompasses public or private utility undertakings or combinations of those. In many cases, water supply and wastewater treatment for other sectors, like industry, are attributed to the respective sector. In general, there is a clear input (need for a certain amount of water with a certain quality) and output (release of a certain amount of water with a certain quality) from the water supply and sanitation sector. It should nevertheless be kept in mind that water supply and sanitation are a human right, giving the water supply and sanitation sector a high priority.

Water management, on the other hand, is concerned with monitoring, controlling and distributing surface water and groundwater. Its purpose is to ensure that all sectors (water supply and sanitation, industry, agriculture, energy, transport, etc.) and ecosystems have sufficient water of adequate quality at their disposal, making a balance between different users and in general ensure that society and economy are not harmed by too much (floods), too little (droughts) or too dirty water. It is not so much about inputs and outputs but about balancing and prioritizing a valuable and often scarce resource and this is pre-eminently a public undertaking. Distinction should therefore be made between the water supply and sanitation sector as utility management and water management as management of a common good (European Parliament, 2019; Ostrom, 2015; United Nations, 2017).

Water and climate change mitigation

Mitigation of greenhouse gas (GHG) emissions includes reducing emissions from the water supply and sanitation sector and from water-intensive sectors like energy and agriculture (Timboe et al., 2019). GHG emissions by the water supply and sanitation sector largely stem from energy used to power the systems and decaying of organic material from water and wastewater treatment. There are currently developments towards energy-positive wastewater treatment plants, deriving their energy from the wastes (Maktabifard et al., 2018). Following this development, expansion of wastewater treatment not only reduces the GHG emissions from untreated wastewater but can become a self-sustaining system or even an energy source. And wastewater can be a source of raw materials, like nutrients, that further contributes to reduced energy required in the extraction of, for instance, fertilizers. Increasing water use efficiency and reducing water losses enables water supply and sanitation systems to contribute to GHG mitigation and at the same time become more cost-effective (UN-Water, 2020), while in some cases reduce transboundary tensions (Lipchin et al., 2016).

Adaptation in water management also has mitigation possibilities. Dam reservoirs contribute to methane (CH_4) emissions and measures can be put in place to reduce these emissions. Wetlands, on the other hand, can be important carbon sinks, that can store twice as much carbon as forests (Anisha et al., 2020). Worldwide, however, wetlands are being degraded and lost, and a poorly managed wetland can become a carbon source. Proper management of wetlands and wetland restauration can therefore be an important mitigating measure. This comes on top of other benefits of wetlands like flood and drought mitigation, water retention and purification, and biodiversity (UN-Water, 2020).

Where water plays an important role in adaptation, it may be clear that mitigation and adaptation are often mutually influencing each other. There is consequently a need to take an integrated approach viewing mitigation and adaptation holistically.

Mainstreaming water and transboundary issues into national policies

Sectoral approaches risk missing the important interactions and cross-cutting issues relating to water management (also see UNDP, 2020). This also becomes clear from the NDCs, that largely focus on reducing

GHG emissions in energy, agriculture, industry and transportation as most important emitters, thereby largely ignoring the fact that nearly all sectors depend on reliable water supply. However, countries have come to realize that water is an important element in developing climate strategies.

There is an urgent need for greater cooperation between the water and climate communities. The climate change community, on the one hand, needs to give greater attention to the central importance of water in addressing the climate change crisis. The water community, on the other hand, should focus more on promoting the importance of water in terms of both adaptation and mitigation and on making any water measures and infrastructure climate-resilient (UNECE, 2009). This ultimately needs to be reflected in national and international strategies, policies and plans, including the NDCs (UN-Water, 2020).

Water management in adaptation and mitigation

Accounting for water in mitigation and adaptation can be done in several ways. Water management considerations are recommended to be included in development and implementation of mitigation and adaptation strategies and plans. This can, for instance, be done by involving the water community in development and revision/update of the NDCs, as well as other climate-related policies, for example, by organising cross-sectoral consultations and getting perspective of the interlinkages and dependencies between water and climate. Based on such consultations, a water paragraph can be developed followed by its inclusion into climate mitigation and adaptation policies, explaining the impacts of the proposed action on the water resources as well as possible impacts/restrictions of (the future availability of) water resources on attaining the policy. As mentioned, elaboration and realization of such a paragraph will require involvement of water managers into policy development and additional efforts and resources to organise this process.

Another point is that a water assessment is needed to review water availability versus water needs in mitigation and adaptation plans. One example of how water assessment can be included into spatial planning under climate change is presented in box 3. Any water management costs associated with the climate policies should be included into the budgetary arrangements to ensure proper implementation. Finally, integral information is needed to support decision-making (UNECE/INBO, 2015; UNECE/UNISDR, 2018).

Box 3. Including water assessment in spatial planning

The Netherlands and Flanders (Belgium) have introduced a 'water assessment' ('watertoets' in Dutch) into their spatial planning which is challenged by climate change. The instrument is meant to include water management considerations in the development of spatial plans and decisions. The water assessment is an obligation to involve water managers at an early stage in the spatial plan development and to justify the way water management interests are included in the plans. The objective of the water assessment is to prevent development of new urban or industrial areas in areas that are unsuitable from the point of view of water management, for instance in flood plains, considering also climate change impacts (Havekes et al., 2017). In practice, the water assessment leads to identification of water issues in spatial planning projects but these issues are not always addressed.

Apply a basin perspective

Worldwide, 153 countries share rivers, lakes and aquifers, and 286 river basins and 592 aquifers cross sovereign borders. Transboundary basins account for an estimated 60 per cent of global freshwater flow and are home to more than 40 per cent of the world's population. Transboundary cooperation in mitigation and adaptation is thus crucial to prevent possible negative impacts of unilateral measures, to prevent maladaptation and to make mitigation and adaptation more effective (for example, by reducing uncertainty through the exchange of data, enlarging the range and location of available measures, and sharing the costs and benefits). It also helps to prevent conflict, reduces existing knowledge gaps, and promotes peace and regional integration, as well as wider economic development (UN-Water, 2019).

As the entire water system is connected, water management measures at one location may influence other locations in the basin and may reduce or increase the effectiveness of measures at those other locations. For

example, installation of water level monitoring stations upstream in one country can help to receive important information for the other country located downstream to reduce flood risk under climate change. Therefore, especially in the case of a transboundary basin, it is important that measures are coordinated over the basin. This also holds true for groundwater systems that are in one way or another connected to the surface, for instance, for recharge. There may also be close connections of groundwater with river systems with mutual influences. As a consequence, basin-wide coordination and cooperation should be mainstreamed into the national climate policies and plans.

The role of River Basin Organisations

In many basins worldwide, River Basin Organisations (RBOs) exist to coordinate and support riparian countries in the management of their shared basins. RBOs are permanent bodies with governance structures supported by intergovernmental and often international partnerships.

River Basin Organisations (RBOs) can support countries' adaptation and resilience-building beyond what each individual country could achieve on its own. They can support the basin countries in the long-term planning and implementation of basin development, and their decision-making bodies function in close alignment with national and regional strategies. RBOs can help coordinate policies and planning, support effective implementation, and avoid the pitfalls of maladaptation, in which good intentions result in unwanted or unpredicted results (World Bank/UNECE, 2019). In basins, that have no formal transboundary legal and institutional framework, other forums for discussion may exist, such as working groups where representatives of authorities, academia and civil society organizations meet and discuss issues of common concern. There have been examples where such forums have filled in some of the functions of RBOs (UNECE/INBO, 2015).

Climate change adaptation strategies have been prepared in some transboundary basins. Such an adaptation strategy can, in turn, facilitate and be linked to national strategies and plans. The International Commission for the Protection of the Danube River (ICPDR), for instance, has developed its adaptation strategy for the Danube River in 2012 and updated it in 2018. Building on the ICPDR Strategy on Adaptation to Climate Change for the Danube Basin, Romania, the Republic of Moldova and Ukraine have developed a new Danube Delta Climate Change Adaptation Strategy (ICPDR, 2014). In such a way, basin-wide strategies and plans can be used to mainstream transboundary water management in national climate policies and plans, like the NDCs.

Box 4. Mainstreaming regional climate change adaptation in national activities within the Lower Mekong Basin

The Mekong River Commission (MRC) has formulated the Mekong Climate Change Adaptation Strategy and Action Plan (MASAP) to address climate change in Lower Mekong Basin. The MASAP sets out the strategic priorities and actions at basin level through which the MRC can contribute to addressing climate change risks and strengthen basin-wide resilience. One of the seven strategic priorities for basin-wide adaptation to climate change is to mainstream climate change into regional and national policies, programmes and plans. Under this priority, a process of identifying national adaptation priorities and selecting potential actions in order to mainstream a regional perspective in national plans, strategies or projects, including NDCs, has been completed in each of the four Member Countries. MRC as a River Basin Organisation in this way supported mainstreaming of transboundary water cooperation in the NDCs (MRC, 2018).

Legal and policy frameworks

Mainstreaming water involves analysing the effects of planned measures across sectors and within sectors on water. Many mitigation and adaptation measures will have an effect on water, but these effects are often not concretised. A systematic evaluation of the current and future water consumption, allocation, and trade-offs can be done. This analysis can help those drafting NAPs and NDCs understand where surface and ground water is currently budgeted and where it might need to be shifted to support climate change mitigation and adaptation activities. This evaluation is particularly critical in regions facing increasing water scarcity or flooding, which disrupts rather than helps water availability (Timboe et al., 2019).

The existing legal and policy frameworks around water governance are the starting point for the analysis of water needs and allocations and should be included in the NDCs. At the international level these are, among others, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the Convention on the Law of the Non-navigational Uses of International Watercourses. Including legal and policy frameworks asks for an integrated and coordinated approach to be able to balance the pressures and needs of all sectors. A common framework needs to be found to effectively address trade-offs between development and environment protection, and also between diverging interests of riparian countries and economic sectors.

A nexus approach to managing interlinked resources has become recognized for its potential to enhance the closely interlinked aspects of water, energy and food security by increasing efficiency, balancing trade-offs, building synergies and improving governance, while also protecting ecosystems. Moreover, achieving the SDGs simultaneously means reconciling different interests and taking into account these interdependencies, notably those related to water and sanitation (SDG 6 including 6.5.2 on transboundary water cooperation), food security (SDG 2), sustainable energy (SDG 7) and environmental protection (SDG 15) that draw from a common pool of globally finite, and sometimes locally scarce natural resources (UNECE, 2018).

Water in the NDCs

Looking at the NDCs, 186 countries have submitted their first NDC in 2015 (UNFCCC, n.d.). 111 of these NDCs mention water as important for adaptation. In 72 NDCs, 'Water management' is mentioned as adaptation measure while 'Watershed and river basin management' are mentioned as adaptation measure in 25 NDCs, 8 of which do not mention 'Water management', and 'Water general' in 5 NDCs (Figure 1). 'Other' include more specific types of measures: 'Water conservation and reuse' (41 NDCs), 'Water supply' (39 NDCs), 'Water infrastructure' (25 NDCs), etc. (Figure 2) (World Bank, n.d.).

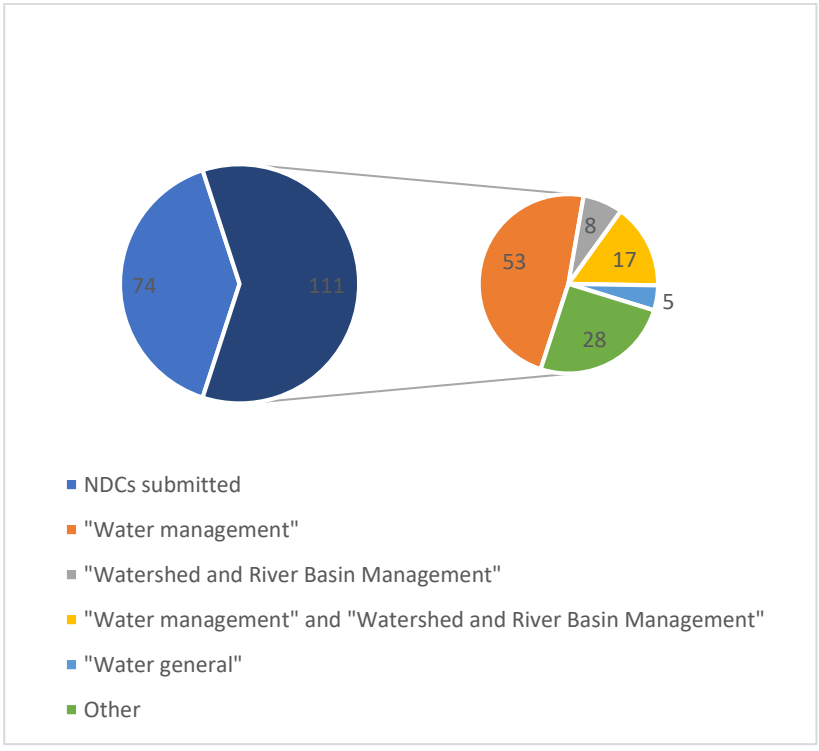

Figure 1: NDCs where water is identified as important for adaptation. The left side circle shows the proportion of these NDCs relative to all NDCs submitted

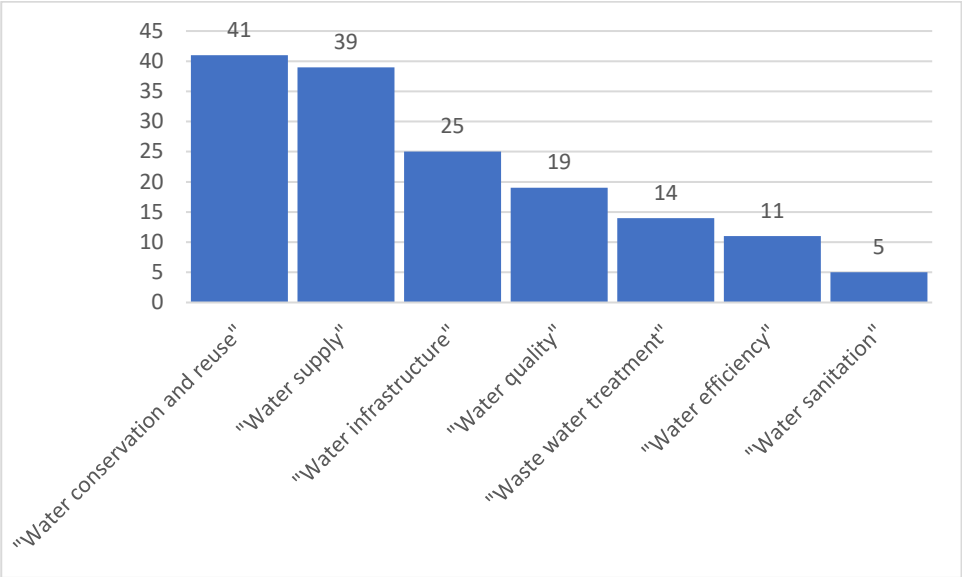

Figure 2: More specific topics in NDCs that identify water as important for adaptation

'Water management' and 'Watershed and river basin management' are not mentioned when it comes to mitigation. 'Wastewater' is mentioned in the framework of mitigation in 27 NDCs as part of sectoral plans. Nevertheless, only 6 explicitly mention methane capture in this context. 'Wastewater treatment' is mentioned in the context of adaptation in 14 NDCs, 5 of which mention 'Wastewater' in the mitigation part. 'Wetlands', finally, are mentioned in the context of mitigation in 9 NDCs, in some cases explicitly mentioning the carbon sink potential of wetlands. 'Wetlands' are mentioned in the context of adaptation in 5 NDCs, 3 of which also mention it in the mitigation part (World Bank, n.d.). Mitigation in water thus largely focuses on wastewater treatment.

Box 5. Country approaches to 'Water management'

Rwanda mentions 'Water management' as important for adaptation. Its measures for national water security include water conservation practices, wetlands restoration, water storage and efficient water use. To this end, water resource models, water quality testing and hydro-related information are planned to be developed and a management plan for level 1 catchments is to be developed and implemented (Republic of Rwanda, 2020).

Lesotho mentions the Lesotho Highland Water Development Project II and Lesotho Lowlands Water Scheme as activities to implement water management. 'Watershed and river basin management' for Lesotho is translated into strengthening the capacity for climate change adaptation through support to the integrated watershed management programme. "*Lesotho is renowned for an abundant supply of pristine water resources. The country constitutes one of Southern Africa's principal water catchment areas, capturing around 50% of the total catchment run-off. The water resource base plays a critical role in advancing socio–economic development and supporting ecosystems integrity. Climate change-induced effects on Lesotho are expected to have a far-reaching regional impact on both the national and regional freshwater resources as the country forms major source of freshwater and drainage areas extending into the Atlantic basin through South Africa, Namibia and Botswana. Effectively, the impact will be detrimental to national and regional water dependent life forms, ecosystems and socio-economic activities*" (LMS, 2017).

The Republic of Moldova sees water resources as one of six adaptation priority sectors. It identifies the water regime effects of climate change for each sector. Management of water resources is incorporated in the Environmental Strategy for 2014-2023 aiming at preventing the degradation of the quality of water resources, the protection and restoration of the wetland environment, and provision of sufficient good quality water based on a sustainable, balanced and equitable use of water. The Republic of Moldova also

identifies mitigation co-benefits from adaptation actions, including from water resources (Government of the Republic of Moldova, 2020).

The Republic of Lebanon plans to improve water security through increasing the artificial recharge of groundwater aquifers and increasing surface storage dams and hill lakes. Also, Lebanon aims at optimizing the use of the current water resources through the rehabilitation of the existing pipe network and the installation of water meters (Republic of Lebanon, 2015).

Afghanistan mentions 'adaptive and integrated water management' without further elaboration. Under the heading 'Watershed and river basin management', Afghanistan mentions capacity building for practitioners for watershed management, planning for proper watershed management through community-based natural resources management and full catchment planning technology and models (Islamic Republic of Afghanistan, 2015).

Uruguay states it plans to have implemented water management models and instruments that promote the rational use of water through reservoirs and dams that are shared among several plots of land by 2025. The country intends to have formulated, adopted and implemented by 2025 three integrated basin management plans that consider climate change and variability. "*Given the strategic importance of water resources and their vulnerability to climate change and variability, the comprehensive and sustainable management of such resources has been defined as a State policy and, therefore, the aim has been to promote the comprehensive and sustainable management approach of our country's water basins. The National Water Policy [..] establishes in Article 11 that "water resources management will seek to achieve an environmentally sustainable use and will take into account climate variability and the extreme events occurrence in order to mitigate the negative impacts, in particular for the communities". In this sense, the National Water Plan [..] has included integrated water management (basins, aquifers and urban waters) participation instruments for which the climate risk approach is essential, especially when it comes to the integrated management of droughts and floods*" (Government of Uruguay, 2017).

Box 5 provides some examples of how countries approach 'Water management'. These examples show a diversity in approaches. Several countries refer to underlying water-related national plans or regulation in their NDC, others state that they intend to develop a plan or strategy with regards to water. In general, there is already a distinction between water management on the one hand and water supply and sanitation on the other when it comes to measures in the NDCs.

Transboundary issues are mentioned for example in the NDCs of:

- The Republic of Moldova ("Support foundational capacity building and targeted research needs for joint, ecosystem-based management of trans-boundary water systems; to ensure international collaboration in climate change and environmental protection" (Government of the Republic of Moldova, 2020);
- Palestine ("Allocate transboundary water resources equitably and reasonably" (State of Palestine, 2017)); and
- Vietnam ("strengthen international cooperation in addressing transboundary water issues; enhance cooperation in scientific research, in information exchange on the formulation and implementation of policies and in the basic content of climate change strategies and policies" (Government of Viet Nam, 2016)).

These three countries are highly dependent on upstream countries for their water resources. Many other countries that report water management as an important issue, however, do not mention transboundary impacts, although many of them are located in transboundary basins.

When it comes to GHG mitigation options from adaptation, very few countries mention such linkages. When mentioned, it relates, among others, to agricultural innovations, forestry and energy (solar power). Under mitigation, one country mentions possible synergies between mitigation and adaptation and one country mentions adaptation possibilities of ecosystems. There is nevertheless little attention for mutual influences between adaptation and mitigation. Some countries recognize the potential role of wetlands in carbon sequestration. The central importance of wetlands for mitigation and adaptation is however not yet reflected in the NDCs (Anisha et al., 2020).

Thus, many intended NDCs address water in the context of adaptation but few include mitigation options from water (Timboe et al., 2019) and virtually none looks at the water availability necessary for implementing their mitigation plans. This can become a serious problem in implementing the NDCs.

How to mainstream water in the NDCs?

As discussed above, water plays a pivotal role in climate change mitigation and adaptation. Ideally water management considerations are taken into account throughout the whole process of developing NDCs. Therefore, water management needs to be mainstreamed in the NDCs. But how can this be done? This section will focus on mainstreaming water in the NDCs, the next section will focus on mainstreaming the inevitable transboundary issues that come into play in many basins around the world.

In the process of mainstreaming water, the following steps are identified (see figure 3):

- Involve the water community in the development of NDCs
- Identify water management implications of climate change
- Identify water effects from mitigation measures
- Identify water effects from adaptation measures
- Adapt the draft NDCs

While these steps in essence are integral part of the process of developing the NDC, the water component is extracted for the sake of this document. The steps will be further elaborated below.

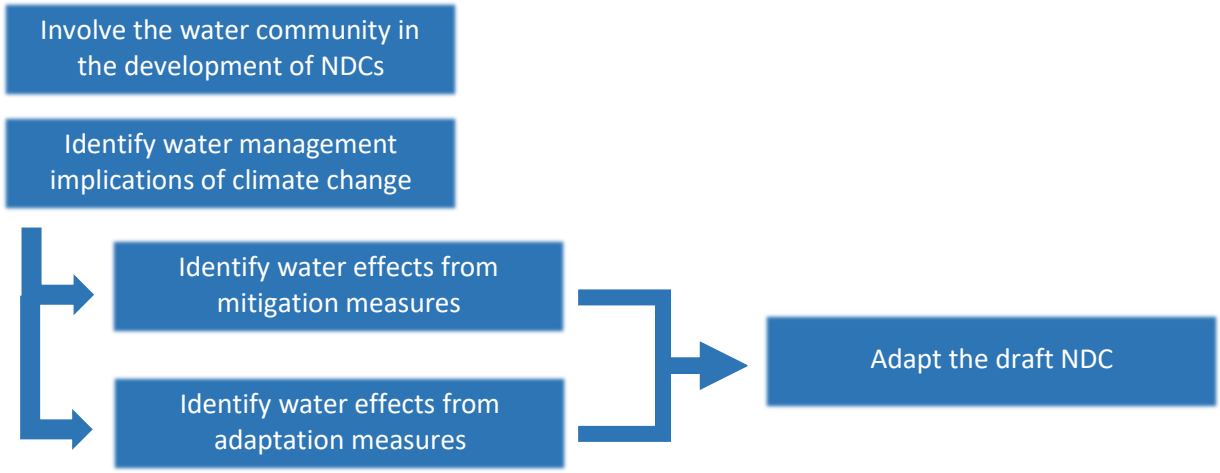

Figure 3: Steps in mainstreaming water in the NDCs

Involve the water community in the development of NDCs

Water management is needed to ensure that the surface water and groundwater that is available through the hydrological cycle can fulfil the socio-economic needs as well as the ecological needs. It has to deal with the demands from a range of sectors, including agriculture, energy, transportation, industry, etc. as well as the impacts of these sectors on the hydrological process in terms of quantity and quality. Additionally, it has to account for preserving ecological systems.

These water management considerations are rarely included in the development of the NDCs. The need to apply an integrated approach to climate change mitigation and adaptation that includes water management as management of a common good is imperative while developing NDCs to address the needs of water-related sectors including the water supply and sanitation sector, and ecosystems. Application of such an approach requires involvement of the water community from the very beginning of development of the NDCs, for example, through consultations, discussions, research, assessments, etc.

Identify water management implications of climate change

Climate change influences the hydrological cycles and with that, the water availability. In general, the variability in water availability increases. Flood and drought regimes become more extreme with many places experiencing both ends of the spectrum successively. Water management may be adapted to this situation by retaining more water in periods with abundant water to be used in periods with water stress. Nevertheless, the overall water availability is decreasing in many areas around the world. On top of this, rising seawater levels lead to salt intrusion in coastal areas. All these effects of climate change have to be translated into adaptation measures for water management. On top of this, most sectors may have to become more water efficient as the water becomes scarcer. These measures should be included as adaptation measures in the NDCs. For example, water use reduction targets for sectors can be set and flexibility mechanisms can be included in water-sharing schemes to account for this climate-induced variability (UNECE / INBO, 2015).

Box 7. Examples of how flexibility is included in transboundary water management

A study into the management of the Great Lakes shared by the United States of America and Canada, with climate adaptation as a main feature provided a range of management options to deal with short-term surprises and provide flexibility to quickly adapt to rapidly changing hydro-climatic regimes. This was done with a combination of flexible water regulation operating rules, coupled with a comprehensive adaptive management plan that focused on land-side changes, such as new flood-plain zoning regulations, flood warning mechanisms and other management measures for which local authorities were responsible.
Source: International Joint Commission, Lake Superior Regulation: Addressing Uncertainty in Upper Great Lakes Water Levels, International Upper Great Lakes Study, final report (Ottawa and Washington, D.C., 2012)
http://www.iugls.org/files/tinymce/uploaded/content_pdfs/Lake_Superior_Regulation_Full_Report.pdf.

The decades-old transboundary cooperation treaty between Mexico and the United States of America was re-evaluated in 2013 to foster more flexibility in a basin that appears to be experiencing both increasing water demand and declining absolute water availability. The treaty provides the possibility to revise or complement the treaty by adding "minutes". Mexico and the United States in 2012 agreed on adding minute 319, which specifies, among other issues, measures to take in the Colorado River Basin in situations of water quantity fluctuations that might be due to climate change.
Source: International Boundary and Water Commission, "Minute No. 319: Interim International Cooperative Measures in the Colorado River Basin throughout 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California" (2012) http://www.ibwc.gov/Files/Minutes/Minute_319.pdf.

The legal framework for cooperation between Spain and Portugal, the 1998 Convention on Cooperation for the Protection and Sustainable Use of the Waters of Portuguese-Spanish Hydrographic Basins (Albufeira Convention), has been made more flexible by an Additional Protocol of 2008 to guarantee some minimum flows that should enter in the Portuguese part of each basin, coming from the Spanish part, taking into account periods of water scarcity and droughts. However, the Parties may invoke exceptional circumstances for not complying with the flow regime, as recorded in some years.
Source: Amparo Sereno, Ríos que nos separan, aguas que nos unen. Análisis jurídico de los Convenios Hispano-Lusos sobre aguas internacionales (Valladolid, Lex Nova, 2011) https://sites.google.com/site/amparosereno.

Climate change also has impacts on sectors that in turn influence water management. Urban heat, for instance, increases the water demand in the city, putting pressure on the water resources and through this on water management. Other affects also take place; thawing of permafrost, for instance, can damage infrastructure that in turn can affect water management. A recent example is the leaking of more than 20,000 tons of diesel into the Ambarnaya River near the city of Norilsk in the Russian Federation after a fuel tank collapsed at a power plant as a result of thawing of permafrost (Nechepurenko, 2020). Both direct and

indirect effects of climate change should be accounted for in the NDCs. All these water management implications of climate change can be based on a vulnerability assessment.

Identify water effects from mitigation measures

For each sector, measures for mitigation are designed. However, each measure can have implications for water management. Strategies in the energy sector towards solar and wind energy can reduce the water demand from energy while strategies towards hydropower can have substantial impacts on the entire hydrological system in a river basin. The production of biofuels will require water for the biofuel crops (UNECE, 2020). If this is designed as production on top of the existing agricultural production, the water demand may increase substantially.

Afforestation and reforestation as mitigation measures will have hydrological effects that can be beneficial for water management but can also reduce water availability (Tubiello & Van der Velde, 2011; Wallis et al., 2014). Restoration of wetlands, especially peatlands, can be an important mitigation measure as they can store more carbon than forests. Damaged peatlands can, on the other hand, be an important source of GHG emissions (UN Environment, 2019). Restoration of wetlands can have implications for water management.

For each of the mitigation measures, the implications for water management ideally should be quantified to the extent possible or at least assessed qualitatively and included in the NDCs. Implications can, among others, be an increase or reduction of water demand, changes in water quality, or changes in hydrology in the basin. Clarifying these impacts provides insight into the feasibility of the measures from the water management point of view.

Identify water effects from adaptation measures

Similar to the mitigation measures, adaptation measures can have implications for water management. Combatting urban heat by creating additional green infrastructure, for instance, may raise the urban water demand while building dams and dikes for flood protection may alter the hydrology in a basin. Levees can be built for flood protection but can also increase flood risk while wetland restoration can reduce flood peaks (Gonzalez & Kuzma, 2020). Such water impacts ideally should be quantified as much as possible or at least assessed qualitatively and put in perspective of the possibilities of water management.

Adapt the draft NDC

Confronting the changing water demands from mitigation and adaptation measures with the limitations and problems in water management in general gives an overview of the feasibility of measures from the water management point of view. If certain measures will lead to (additional) problems in water management, the measures may need to be adapted. For instance, growing biofuel crops as a mitigation measure in a situation where scarce irrigation water is already limiting food production may not be a suitable measure. By applying the water ‘lens’, the measures as developed for the NDC may have to be reconsidered.

Mainstreaming transboundary issues in the NDCs

The process of mainstreaming transboundary aspects

Water management has to take a basin approach to be effective for the reasons mentioned above. In many cases, this implies that transboundary effects of climate change and climate change measures are recommended to be taken into account. It should be noted that transboundary cooperation is also relevant within countries, like federal states or between provinces. The following steps are identified to mainstream transboundary issues in the NDCs:

- Identify transboundary effects of climate change
- Identify transboundary aspects of mitigation and adaptation measures
- Identify benefits of cooperation
- Include joint and/or coordinated strategies, plans and measures

These steps will be further elaborated below.

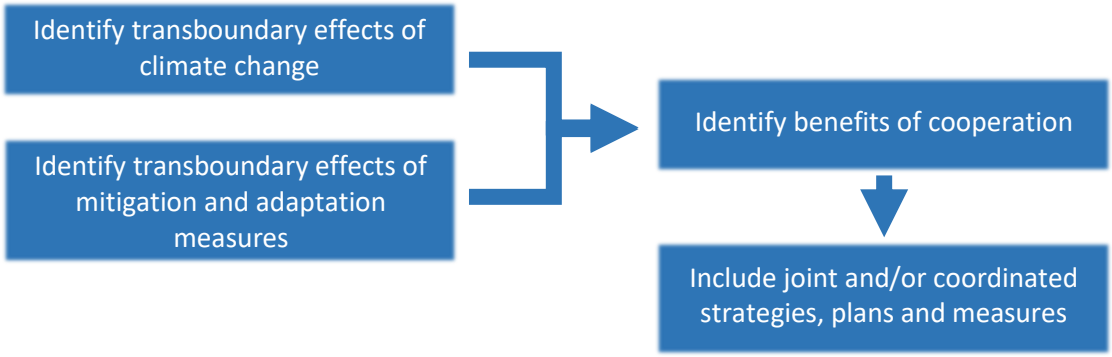

Figure 4: Steps in mainstreaming transboundary issues in the NDCs

Identify transboundary effects of climate change

Climate change has effects on the hydrology in a basin, leading to lesser or higher run-off or both, depending on the season. Moreover, different parts of a basin may experience different changes. And changes in land use and water use can affect the hydrology. This ultimately has effect on the amount of water flowing from one country to another. A joint assessment of the hydrological changes and their impacts on different sectors in the basin (e.g. vulnerability assessment) will help to identify the changes and support development of relevant measures to mitigate and adapt to them. It may also reduce the risk of disputes and conflict between countries sharing a basin, as it can be clarified that certain changes occur as a result of climate change, not as a result of water management measures. Besides, countries collaborating in water management experience a range of benefits, including access to funding, accelerated economic growth and international trade, improved human well-being, enhanced environmental sustainability, food security, improved governance and regional integration (UNECE, 2015; UN-Water, n.d.).

As these changes may be different in different basins, a country having more than one basin may have to define different water management measures in the different basins. Where, for instance, in one basin the flood risk increases, in another the drought risk may increase (e.g. India and Australia). This requires a different water management approach for each basin, and this should be reflected in the strategies and plans.

Identify transboundary aspects of measures

Measures that influence water management in a transboundary basin can have upstream or downstream effects. For example, if one country expands its irrigated land, downstream countries may receive less water. Estimates of these changes are needed to be able to distinguish between changes caused by climate change and changes caused by adaptation and mitigation measures. The mitigation and adaptation measures should therefore be assessed relative to their effects on the riparian country or countries. It is useful to communicate such effects with the respective country. For instance, if a measure is defined to restore a wetland located at the national border as a mitigation measure it will be useful to know if the bordering country has plans to change their wetland management. Joint restoration of a wetland may be much more effective than if only one side works on it (see, e.g., the Prespa Ohrid Nature Trust, Box 9).

Box 8. Accounting for transboundary aspects of measures

The four countries of the Lower Mekong Basin — Cambodia, the Lao People's Democratic Republic, Thailand and Vietnam — signed an Agreement on Cooperation for the Sustainable Use of the Mekong River Basin (Mekong Agreement) in 1995. The "Procedures for Maintenance of Flow on the Mainstream" under this agreement acknowledges hydrological variability, changes and development effects on the river's flow. It regulates for a natural flow to be maintained except in times of severe droughts and floods.

These Procedures provide a useful framework for ensuring the health of the river's ecosystem and the sustainable development of its resources even under climate change conditions.
Source: Mekong River Commission (2004), Procedures for Maintenance of Flow on the Mainstream http://www.mrcmekong.org/assets/Publications/policies/Procedures-Maintenance-Flows.pdf.

The conditions for sustainable flood protection for the Sava River Basin are set by the Protocol on Flood Protection to the Framework Agreement. The Protocol acknowledges the likely consequences of climate change on the water regime in the Sava River Basin and the need for effective adaptation measures. By signing the Protocol, the countries in the basin agreed to cooperate on flood risk management taking into account the impacts of climate change.
Source: International Sava River Basin Commission (2010), Protocol on Flood Protection to the Framework Agreement on the Sava River Basin. http://www.savacommission.org/basic_docs.

For the Acre River Basin (Brazil, Peru and Bolivia), a tri-national early warning system was developed and implemented. Responsible staff members from relevant local institutions were trained to operate the early warning system. To support the warning system, a new radio communication system was installed. Solid joint efforts and cooperation of national, regional and local governments and the essential civil actors are the basic conditions to guarantee the sustainability of the tri-national early warning system.
Source: ACTO (2018), Amazon waters: 10 Research Projects on the World's Largest River Basin. http://www.otca-oficial.info/assets/documents/20181022/94b35b78327fb57880022313327a00f3.pdf.

The Republic of Moldova and Ukraine have developed the Strategic Framework for Climate Change Adaptation as well as its Implementation Plan for the Dniester River Basin for timely adaptation to climate change. Transboundary climate change adaptation activities are coordinated by the Commission on Sustainable Use and Protection of the Dniester River Basin (the Dniester Commission) and are integrated into river basin management planning. Findings and measures proposed by the Strategic Framework and its Implementation Plan were taken into account by the national authorities while developing national climate change planning.
Sources: https://dniester-commission.com/wp-content/uploads/2019/09/Dniester_English_web-1-1.pdf and https://dniester-commission.com/wp-content/uploads/2018/12/ImpPlan_Engl_web.pdf.

Box 9. Prespa Ohrid Nature Trust (PONT)
The Prespa Ohrid Nature Trust–PONT is a transboundary conservation trust fund dedicated to conserving the Prespa Ohrid ecoregion and its rich natural and cultural heritage. The region is located at the heart of Balkans and covers parts of Albania, Greece and the Republic of North Macedonia. PONT was established, among others, by the realisation that interventions in both water and wetland management needed to be designed, managed and monitored at transboundary level as no state alone could resolve the complex of interlinked issues (PONT, 2020) especially under the circumstances of climate change.

Identify benefits of cooperation

Cooperation can improve and augment the effects of measures. For instance, if an upstream country takes a flood reduction measure, the downstream country may benefit from this. Sometimes a little extra effort from the side of the upstream country can have a beneficial effect for the downstream country. The upstream country may then be compensated for its extra efforts instead of the downstream country implementing its own measures. But cooperation can also extend beyond the water domain. If, for instance, a downstream country expands its energy network, excess water supply may be transmitted upstream in the form of energy resources. In this way, benefits and costs can be shared between the riparian countries.

There are several options to agree upon cost and benefit sharing between riparian countries (UNECE, 2015):

- Connect issues: Make a connection between upstream-downstream concerns and vice versa. These can include issues within the water domain (for instance, ensure upstream to downstream minimal discharge versus downstream to upstream navigation possibilities) or outside the water domain (for

instance, ensure upstream to downstream minimal discharge versus downstream to upstream energy provision).

- Reciprocity (good relations): Accept an agreement that may perhaps have less favorable terms in order to keep good relations and to create a "reservoir of goodwill" with other riparian countries.
- Enlarge the geographical scope: Extend the scope of a basin agreement to cover additional basins on which connecting issues (see above) is possible (for instance, linking negotiations over the Colorado and the Rio Grande Rivers between Mexico and the United States of America).
- Compensation: Provide (financial) compensation in return for a concession (for instance, an agreement between Finland and the Russian Federation for compensation of energy production loss to ensure flood protection).

In many cases, cost and benefit sharing are a combination of two or more of these options. Moreover, cooperation can extend the geographical action space by determining the most effective location for a measure irrespective of the administrative boundaries that benefits most and thus ultimately work at the least cost. Cooperation can also reduce loss and damage as well as reduce transaction costs (UNECE, 2015). Finally, cooperation opens up possibilities for joint funding proposals (World Bank/UNECE, 2019).

Include joint and/or coordinated strategies, plans and measures

Based on the assessment of benefits and costs of cooperation, the implementation of measures can be coordinated, and/or a joint strategy/plan can be developed. NDCs should therefore consider developing transboundary water policies, strategies, plans and measures as well as other mechanisms for cooperation addressing climate change and water management since this can result in sharing costs and benefits as well as lead to improving transboundary cooperation over water management. As stated above, RBOs can play a crucial role in bringing transboundary perspectives to national climate planning processes as well as facilitating cross-border and intersectoral dialogue. The Water Convention can also support countries in this process by providing guidance, facilitating exchange of knowledge and experience as well as sharing good practices and lessons learnt from the field (UNECE, n.d.).

Box 10. Options to consider in transboundary basins, whether national, state or municipal boundaries

- Balancing between water demands and water availability in the shared basins
- Consulting and coordinating with the riparian countries/administrations on water-related measures in shared basins they plan to include and implement according to their enhanced NDCs
- Using river basin organizations as facilitators and platforms for transboundary and regional consultations, discussions, research and assessments while developing NDCs
- Developing and implementing joint transboundary policies, strategies, plans, measures and projects to adapt to climate change in shared basins.

Water effects of mitigation measures

By and large, three types of mitigation measures can be distinguished (see table 1):

1. Reduction of GHG emissions;
2. Reduction of energy use; and
3. Storage of greenhouse gases.

Reduction of GHG emissions in energy production can be attained through changing to other types of energy production including nuclear-, wind-, solar-, hydro-, geothermal- and bioenergy, and by preventing methane (CH_4) leakage. Changing to other types of energy production can have influence on the water use of energy production [2]. Nuclear energy in general requires substantial amounts of water, comparable to coal fuelled

[2] Construction of the energy-producing devices requires water for all types of energy production. In general, water use during energy production far outweighs water use during construction and is therefore not included here.

power plants (Rathi, n.d.). Depending on if nuclear energy is replacing or additional energy production, the water use may increase. Wind energy demands no water during energy production. Using PV panels also does not need water during energy production. If wind and PV replace other energy production, it will lead to water use reduction. Concentrated Solar Power (CSP) on the other hand demands almost as much as coal powered plants (Rathi, n.d.). Hydropower in principle returns the water after use but may increase evapotranspiration from the reservoirs. In a closed loop system, in principle, geothermal energy production uses no water. In other types of geothermal power production, steam may be released and not all water may be reinjected. Also, there is a risk of contaminating the groundwater. Water use of bioenergy, finally, is highly dependent on the type of biomass used for energy production. In general, any biomass will require water to grow.

Other ways of reducing GHG emissions can be found in improved waste management, changes in industrial production, and changes in agricultural production like livestock, soil management and rice production. The effects on water management are highly dependent on the type of measure and the geographic context.

Reduction of energy use can take many forms, like changing from coal to gas, using energy-efficient engines, improving public transport to reduce car use, or behavioural changes. In general, less energy use leads to less water use for energy production.

Storage of greenhouse gases can roughly be done through technical processes (Carbon Capture and Storage (CCS)) or natural processes (Agriculture, Forestry and Other Land Use (AFOLU)). CCS technologies use substantial amounts of water and energy, which also uses water. Estimates are that CCS increases the water use by 45 – 90% (Eldardiry & Habib, 2018). Changes in AFOLU is dependent on the type and implementation of the measure. Afforestation and reforestation, for instance, will generally lead to a higher water use (Bentley & Coomes, 2020; Cunningham et al., 2015). Peatland restoration and management in general requires water level management. The net water quantity effect is dependent on the local situation. In general, AFOLU measures have beneficial adaptation effects like flood and drought reduction and improved water quality while the overall water quantity effects will be limited.

Type of mitigation measure			Potential effect on water
Reduction of GHG emissions	Nuclear energy		Growing water use
	Wind energy		Reduced water use
	Solar energy	PV	Reduced water use
		CSP	Growing water use
	Hydro energy		Growing water use
	Geothermal energy		Groundwater contamination
	Bioenergy		Growing water use
	Other		Variable
Reduction of energy use			In general, reduced water use
Storage of greenhouse gases	CCS		Growing water use
	AFOLU		Limited but variable
			Improved water quality

Table 1. Overview of different types of mitigation measures and their potential effect on water

Overall, there is a need for a nexus approach, looking at the trade-offs between the different measures (UNECE, 2020). A methodology to develop a nexus assessment was developed by UNECE (UNECE, 2018) as well as examples of such assessment in transboundary basins (UNECE, 2017a, 2017b, 2017c).

Water effects of adaptation measures

Many adaptation measures target water, reducing floods and droughts and improving the water quality. As such, the water effects are part of the measure. Nevertheless, there may be measures outside water adaptation that may influence water management. Increasing green and blue areas in cities to reduce the urban heat effect can lead to less use of air-conditioning as a mitigation measure, for instance, but may also

lead to a limited increase in the demand for water to maintain the blue-green areas. It should also be kept in mind that adaptation measures can contribute to mitigation, largely through carbon storage. Again, a nexus approach, balancing between water, energy, food production and ecosystems, provides a way to assess the interlinkages of all measures, either adaptation or mitigation (UNECE, 2020).

Conclusions

- Water plays a central role in dealing with climate change. Any strategy or plan on future development, including NDCs, should therefore account for water as a cross-cutting issue.
- It is important to apply an integrated approach to water management as management of a common public good, which is not a sector, but a general government activity that is of importance for all sectors including water supply and sanitation as well as for other water-related sectors (e.g. energy, industry, agriculture, forestry, etc.) and ecosystems.
- Mitigation and adaptation measures can have substantial effects on water management, often enlarging the demand for water. These effects should therefore be addressed in the NDCs to ensure that the measures are implementable from a water management point of view.
- As adaptation measures can have climate change mitigating effects and vice versa, adaptation plans should be integrated into the NDCs. Together with including water management, this allows for an integrated approach towards sustainable development.
- As water management measures can have effects on the entire basin, transboundary effects and options for cooperation, taking into account all administrative borders, should be included in the NDCs.
- RBOs, international institutions and international agreements can support and enhance transboundary cooperation, also keeping in mind that cooperation can have significant benefits
- The water community should be involved in the NDCs development through a consultative process complemented by the relevant research and assessments.

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